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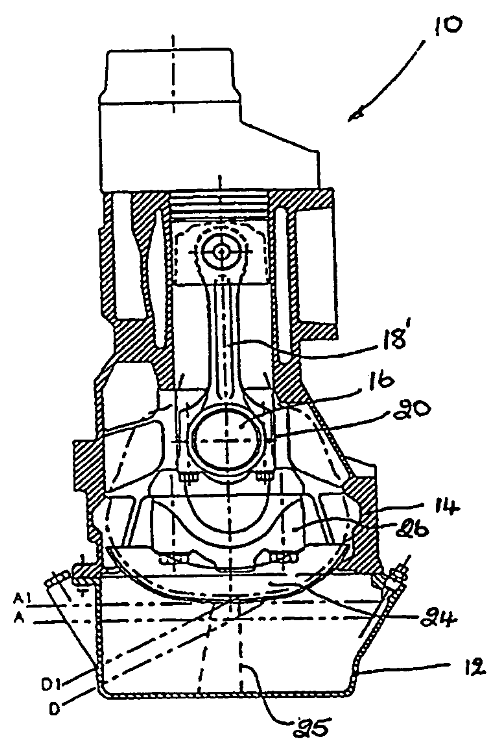
(57) Abstract

An internal combustion engine (10) having an oil sump (12) mounted below an engine block (14), said engine block accommodating a crankshaft (16) and its associated connecting rods (18), wherein the engine includes a barrier means (24) located at a position adjacent a lowermost point in the sweep of a big end (20, 22) of one of said connecting rods, said barrier means being dedicated to the said connecting rod and acting to restrict oil contained in the sump reaching the vicinity of the connecting rod big end during a lowermost portion of its sweep.



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AN INTERNAL COMBUSTION ENGINE HAVING AN INCREASED LUBRICATING OIL CAPACITY AND/OR INCREASED GRADIABILITY

The present invention generally relates to internal combustion (i.c.) engines and, in particular, to internal combustion engines having an increased lubrication oil capacity and/or gradiability.

Oil sumps on i.c. engines are required to contain oil for the lubricating requirements of the engine under a wide variety of engine operating conditions. The quantity of oil required to be contained in the sump depends upon a number of factors including the type of duty for which the engine is to be used, the shortest acceptable servicing interval, the engine size, the environment in which the engine is to be operated and the cooling effect of oil flowing through and around the components of the engine.

In particular, the constant move towards higher specific power outputs and wider servicing intervals places demands on the lubricating and cooling performance of the engine oil which are increasingly difficult to satisfy without enlarging the engine oil capacity. An increase in the oil capacity of an engine can benefit servicing intervals because there will be a larger volume to accept a given quantity of contaminants. A larger capacity can also reduce engine operating temperatures to the benefit of both oil life and engine components such as crankshaft bearings.

In modern diesel engines, it is known to retard fuel injection timing by predetermined amounts. This can lead to greater soot contamination of lubricating oil.

Increasing the oil capacity of the sump can redress this problem and even allow the service interval for oil changeover to be increased.

Enlarging the oil capacity by increasing the maximum level in a sump can, however, have very undesirable effects. The main problem is the increased possibility for windage, this being a tendency for the sweep of a crankshaft journal and its associated connecting rod big end to pick up oil from the sump and throw it around the inside of the engine, thereby increasing oil temperature, oil consumption and emissions and reducing engine efficiency. Windage can occur even where the sweep of the connecting rod big end is above, but close to, the sump oil level.

A commonly adopted practice to permit the raising of the maximum oil level in a sump, and thereby the oil holding capacity, is to provide a perforated baffle or 'windage tray' between the crankshaft and the surface of the oil in the sump. However, whilst this will assist in reducing windage when the engine is running at a normal horizontal inclination, windage can still occur when the engine is inclined above the horizontal inclination or when inertial forces resulting from vehicle direction changes cause oil to translocate from beneath to above the baffle through its perforations.

US 3,100,028 teaches increasing the oil capacity of an i.c. engine by extending a lower portion of a sump in an outward direction. However, this increase in width inevitably leads to an increase in the engine envelope size and can result in the sump wings fouling the vehicle chassis or bodywork.

An alternative means of increasing the oil capacity of an engine whilst reducing the risk of windage is disclosed in US 5,479,886 wherein it is taught to provide restrictions against oil return to the sump from upper regions of the engine so that these upper regions act as supplementary oil reservoirs during engine operation. The restriction to oil return to the sump from the upper regions is brought about by compelling the oil to negotiate a number of small diameter drain holes.

A further restriction to oil return is taught in US 5,479,886, namely the inclusion, in upper regions of the engine, of oil retaining chambers from which oil cannot drain back to the sump irrespective of whether the engine is operating or not.

The teaching of this latter prior art reference has several drawbacks. Firstly, the small drain holes may become blocked with the products of combustion or other foreign material contaminating the oil and thus prevent oil returning to the sump. Secondly, when the engine is due for servicing it will have to stand for some considerable time after being operated to allow the oil to drain to a removal point. This standing time could be lengthy if the oil has not thoroughly warmed and is therefore of a high viscosity. There is therefore a risk of new oil being introduced before the old oil has been substantially removed. Thirdly, no means is disclosed in US 5,479,886 to ensure that the oil deliberately trapped by the non-draining oil chambers is free of contaminants, such as the residues of combustion, which may be released into the 'clean' lubricating oil subsequent to an oil change.

The problem of providing an engine with a high oil capacity is exacerbated by the requirement for some engines to operate at steep inclinations above the horizontal such as is experienced in earthmoving equipment or lifeboat vessels. The tendency for windage in an engine escalates as the angle of operation increases and will be particularly noticeable at a lower end of an inclined engine because the sump oil level will have been brought into closer proximity to the rotating crankshaft. In such a case, the maximum operating angle is dependent upon the angle at which windage will commence at a lower end of the engine.

A further problem is the difficulty in indicating to the operators of equipment the point at which the limit of allowable engine operating inclination has been reached. The limiting angle is commonly lower than the angle which an operator would wish to operate the equipment at, therefore the lower the designated maximum angle of operation, the greater the risk of it being exceeded. A comparatively low maximum angle not only restricts the use of the equipment but also increases the risk of abuse of the intended maximum angle and if this abuse introduces windage, it may well lead to overheating, increased emissions and increased oil consumption in the engine.

It is an object of the present invention to provide a means for increasing the sump oil capacity of an internal combustion engine whilst obviating the drawbacks hereinbefore described.

It is a further object of the present invention to provide for increasing the gradiability (the allowable angle

of operation) of an internal combustion engine whilst obviating the drawbacks hereinbefore described.

According to the present invention there is provided an internal combustion engine having an oil sump mounted below an engine block, said engine block accommodating a crankshaft and its associated connecting rods, wherein the engine includes a barrier means located at a position adjacent a lowermost point in the sweep of a big end of one of said connecting rods, said barrier means being dedicated to the said connecting rod and acting to restrict oil contained in the sump reaching the vicinity of the connecting rod big end during a lowermost portion of its sweep.

The features of the present invention will be more readily understood from the following description of preferred embodiments, by way of example thereof, with reference to the accompanying drawings, of which:-

Figure 1 is a cross-sectional end view of an embodiment of an i.c. engine in accordance with the invention illustrating an increased sump oil capacity;

Figure 2 is a cross-sectional side view of the engine of Figure 1;

Figure 3 is a cross-sectional end view of the embodiment of the i.c. engine in accordance with the invention illustrating an increased gradiability;

Figure 4 is a cross-sectional side view of the engine of Figure 3;

Figure 5 is an isometric view of the barrier device of the present invention before fitting to an engine.

Referring to the drawings, Figure 1 is a cross-sectional end view of an engine 10 in which it may be desired to raise the maximum sump oil level to give increased service intervals or improvements in engine or lubricating oil life but without also increasing the occurrence of oil windage. The engine 10 is fitted with a conventional oil sump 12, which acts as a reservoir for the engine oil. The sump 12 is mounted on the engine block 14. The engine block 14 accommodates a crankshaft 16 and its associated connecting rods 18. Line 'A' in Figure 1 represents a designed maximum oil level that might be seen in the engine when it is in a nominally upright (horizontal) position before being fitted with the barrier device of the present invention. Line 'D' represents a corresponding oil level when the engine 10 is operated at an allowed maximum transversal angle. If the oil level in the engine is increased above the level represented in Figure 1 by line 'A', there will be a risk of oil windage and the resulting problems described hereinbefore when the engine is in operation. The maximum oil level represented by line 'A' will, of course, vary for different engines.

Figure 2 is a cross-sectional side view of the engine shown in Figure 1. Line 'A' again represents the designed maximum oil level when the engine is in a nominally upright position and line 'E' represents a corresponding oil level when the engine is operated at an allowed maximum longitudinal angle.

Figure 5 shows the barrier device 24 of the present invention, which is generally cup-shaped. The device is a dedicated barrier, which is intended to be mounted beneath and shield a single connecting rod of the engine. In a preferred embodiment of an engine in accordance with the invention two such devices are required, one to shield a big end 20 of a first connecting rod 18′ and one to shield a big end 22 of a last connecting rod 18″ of the crankshaft 16 from both direct contact and windage contact with the oil carried by the sump 12 when the engine 10 is inclined transversely and/or longitudinally during operation.

Providing dedicated barriers 24 to be mounted beneath individual connecting rods of the engine minimises the increase in weight of the engine and benefits engine efficiency by only providing windage barriers in the areas where windage is most likely to occur.

Preferably, each barrier device 24 is gondola-shaped to closely follow the path of its associated big end (20,22) of the connecting rods (18′, 18″) so that the big ends pass close to, but do not touch, their respective barrier devices 24. Preferably also, the barrier device 24 is retained in position by a screw fixing of a convenient engine main bearing cap 26 by means of brackets 28, although it will be appreciated that various other locating and supporting means may be used. For example, as shown in broken outline in Figures 1 and 2, the barrier devices 24 could be supported on and fixed to the sump 12 by mounting means 25 which could be formed integrally with the sump 12. The barrier device 24 may be formed independently, of or integrally with, the brackets 28 by stamping from a sheet metal material. Alternatively, the barrier device 24 may be formed from a

plastics material and may be formed by an injection moulding process.

The maximum oil level in an engine fitted with the present invention may be provided at a higher level, shown as 'A1' in Figures 1 and 2, thereby substantially increasing the volume of oil that may be held within the oil sump. The increase in maximum oil level during nominal upright engine position will result in a corresponding increase in oil level during engine operation at maximum transversal and longitudinal operating angles, shown respectively by lines 'D1' and 'E1' in Figures 1 and 2. However, the shielding of the connecting rod path by the relevant barrier device 24 will deter oil windage by preventing sump oil reaching the vicinity of its associated big end (20,22) during a lowermost portion of the sweep of the big end (20,22).

There tends not to be copious amounts of oil draining down from within an engine cylinder but oil caught by the barrier devices 24 as a result of oil splash or drain will be purged by the sweeping movement of the connecting rod big end (20,22) and its corresponding crankshaft journal. This will ensure that contaminants do not become concentrated within the devices 24 and hence contaminate new oil introduced during an engine oil change.

The present invention allows the volume of oil which can be carried by the oil sump 12 of an engine 10 to be increased and this, in turn, provides longer engine service intervals and reduced engine oil temperature elevation during arduous engine operation. The increase in the oil capacity of the sump will be in the range of 20% to 40%.

Figures 3 and 4 show the i.c. engine 10 in accordance with the present invention illustrating that the engine 10 can be angled transversely and/or longitudinally to a greater extend than is possible with the same engine not including barrier devices 24 in accordance with the invention without the need to reduce the quantity of oil in the sump in order to avoid windage.

In some end uses, lifeboats for example, it may be very important for an engine to be able to withstand very high gradient operations without oil windage but, whilst the extended servicing intervals and other benefits provided by the present indention may not be essential in this case, it may be desirable to at least maintain a sump oil capacity similar to that which lesser-duty engines enjoy. The arrangement illustrated by Figures 3 and 4 provides an improvement in this respect.

In Figures 3 and 4, Line 'A' again represents the designed maximum oil level that might be seen in an engine in the nominally upright position. The maximum oil level is intended to remain at or about line 'A' and two barrier devices 24 are fitted to shield a first and a last connecting rod big end (20,22) as described above.

This arrangement will permit notably increased engine operating angles before the onset of windage. Lines 'B' and 'C' represent typical maximum transversal and longitudinal operating angles in normal practice whilst line 'B1' and 'C1' represent the corresponding angles that may be obtained with the present invention.

The present invention will provide an increase in the permitted transversal and/or longitudinal angle of operation of an engine by an amount in the range of 10° to 20°.

Whilst, for simplicity, the benefits of the present invention have been described in relation to one transversal and one longitudinal direction of engine inclination, it will be clear that the present invention permits the engine to be angled by similar amounts in the opposite directions of inclination with similar benefits.

It will also be appreciated that for some engines it will only be necessary to employ one barrier device to shield one connecting rod big end at one end of the crankshaft and that, for other engines, it may be advantageous to employ more that two barrier devices and even one for each connecting rod big end. This enables the total weight of the engine to be closely controlled as there is no need to provide a windage tray that extends the full length of the engine block as in the known prior art cases. In this was, the efficiency of the engine can be increased whilst the overall cost of the engine is reduced.

The present invention can be quickly and simply retro-fitted to existing engines and will have an immediate effect on the efficiency of the engine without notably impairing the free draining of oil from upper parts of the engine into the oil sump.

The present invention also lends itself to easy maintenance and repair as the barrier device can be easily removed from the engine and repaired or replaced as necessary. This reduces the down time of the engine during

maintenance and therefore increases the efficiency of the engine during operation.

CLAIMS

1. An internal combustion engine having an oil sump mounted below an engine block, said engine block accommodating a crankshaft and its associated connecting rods, wherein the engine includes a barrier means located at a position adjacent a lowermost point in the sweep of a big end of one of said connecting rods, said barrier means being dedicated to the said connecting rod and acting to restrict oil contained in the sump reaching the vicinity of the connecting rod big end during a lowermost portion of its sweep.

2. An i.c. engine as claimed in claim 1, wherein the barrier means generally encloses a zone surrounding the lowermost portion of the sweep (path) of the connecting rod big end.

3. An i.c. engine as claimed in claim 1 or 2, wherein the barrier means has a shape which closely follows the lowermost portion of the sweep of the connecting rod big end.

4. An i.c. engine as claimed in any of the claims 1, 2 or 3, wherein the barrier means is generally cup-shaped.

5. An i.c. engine as claimed in claim 4, wherein the barrier means is generally gondola shaped.

6. An i.c. engine as claimed in any preceding claim, wherein the barrier means is formed by stamping from a sheet material.

7. An i.c. engine as claimed in any preceding claim, wherein the barrier means is mounted by bracket means to the engine block.

8. An i.c. engine as claimed in claim 7, wherein the barrier means is mounted by bracket means to a main bearing cap of the engine block.

9. An i.c. engine as claimed in any one of claims 1 to 6, wherein the barrier means is mounted on the sump.

10. An i.c. engine as claimed in claim 9, wherein the means for mounting the barrier means on the sump are formed integrally with the sump.

11. An i.c. engine as claimed in any preceding claim, wherein the engine includes a dedicated barrier means for each connecting rod.

12. An i.c. engine as claimed in any one of claim 1 to 9, wherein the engine includes a dedicated barrier means for each of the two connecting rods located towards respective opposite ends of the crankshaft.

13. A sump for an internal combustion engine as claimed in any one of claims 1 to 12, wherein the sump includes a barrier means mounted therein, said barrier means being arranged in the sump such that, when the sump is mounted below the engine block, the barrier means locates adjacent a lowermost point in the sweep of a big end of one of the crankshaft connecting rods.

14. A means for barring, in use, oil contained in the sump of an i.c. engine from the vicinity of a connecting rod

big end during a lowermost portion of its sweep, said means being dedicated to the said connecting rod and comprising a plate means formed to be generally cup-shaped and having means for mounting it below the connecting rod.

15. A barrier means as claimed in claim 14, wherein the plate means is generally gondola shaped.

16. A barrier means as claimed in claim 14 or 15, further comprising means for mounting the plate means to the engine block or sump of an engine.

17. A barrier means as claimed in claim 16, wherein the mounting means comprises bracket means integrally formed with the plate means.

18. A barrier means as claimed in any one of claims 14 to 17, wherein the plate means is formed by stamping from a sheet material.

19. A method of operating an internal combustion engine having an oil sump mounted below an engine block, said engine block accommodating a crankshaft and its associated connecting rods, the engine including a barrier means located at a position adjacent a lower-most point in the sweep of a big end of one of said connecting rods, said barrier means acting to restrict oil contained in the sump reaching the vicinity of the connecting rod big end during a lowermost portion of its sweep, wherein the oil level in the sump is set at a level between a lowermost and highermost point of the barrier means when the engine is at a normal inclination.

20. An internal combustion engine substantially as hereinbefore described with reference to the drawings.

21. A sump for an internal combustion engine substantially as hereinbefore described with reference to the drawings

22. A barrier means for an internal combustion engine substantially as hereinbefore described with reference to the drawings

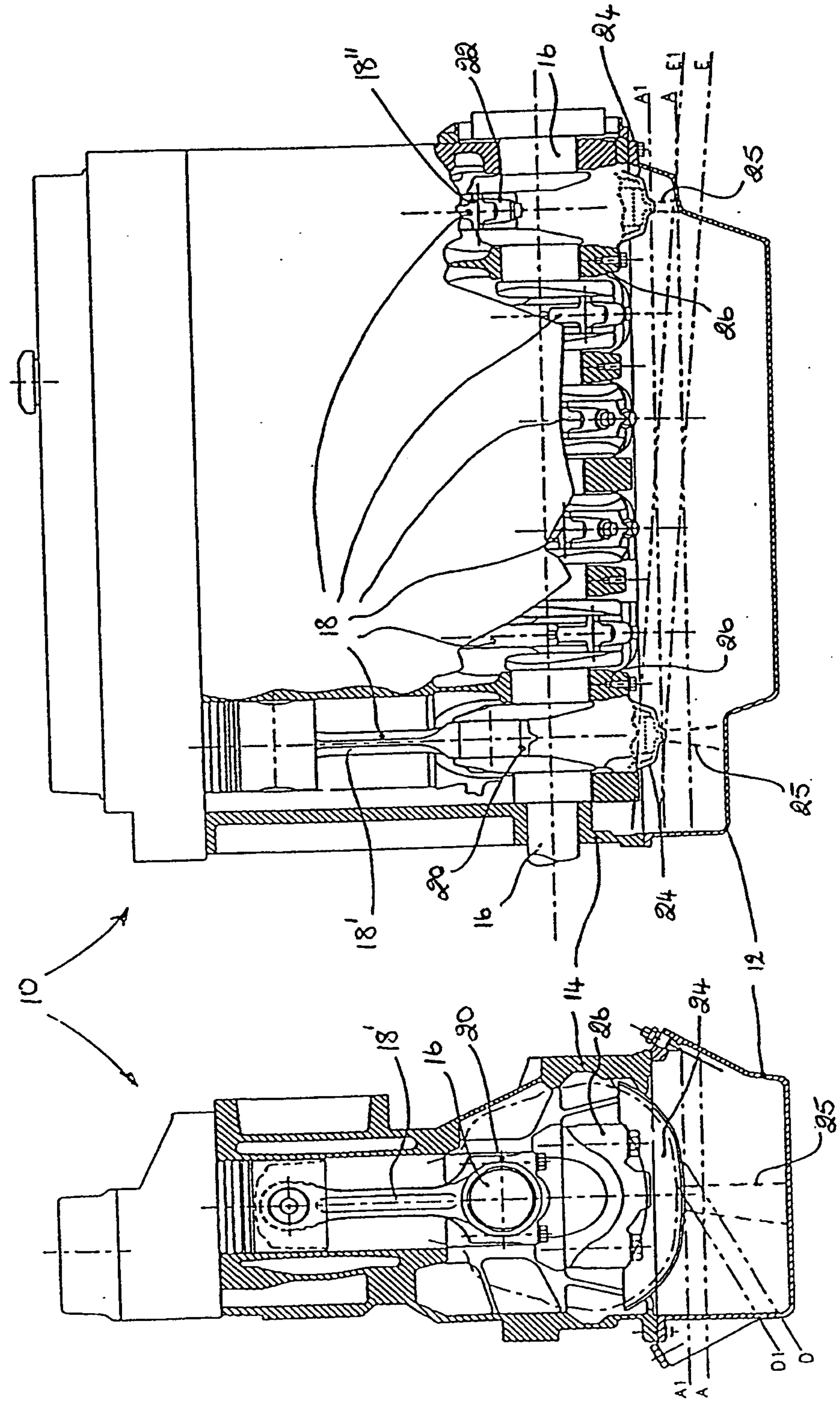

FIG 2

FIG 1

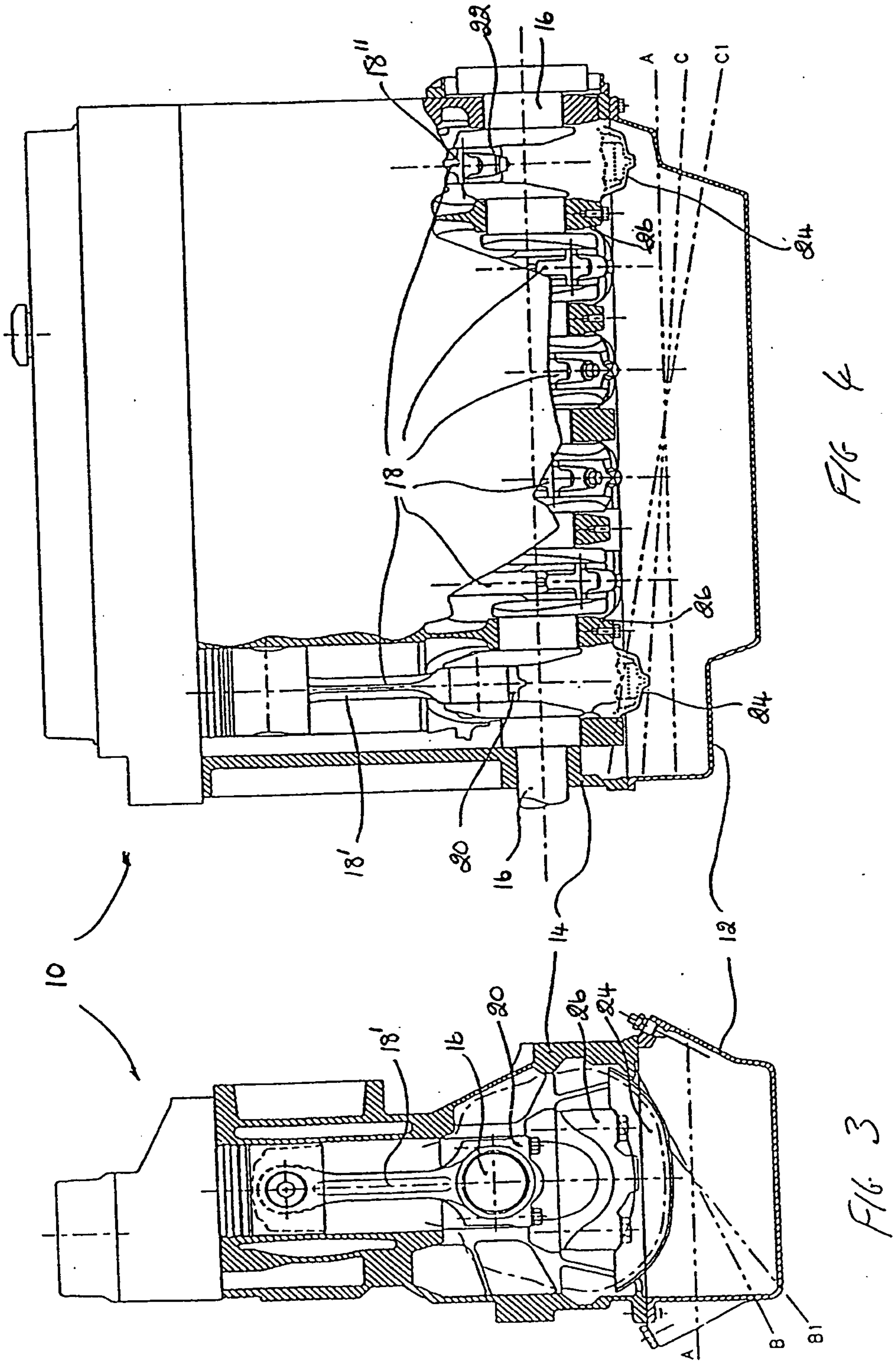

FIG 3

FIG 4

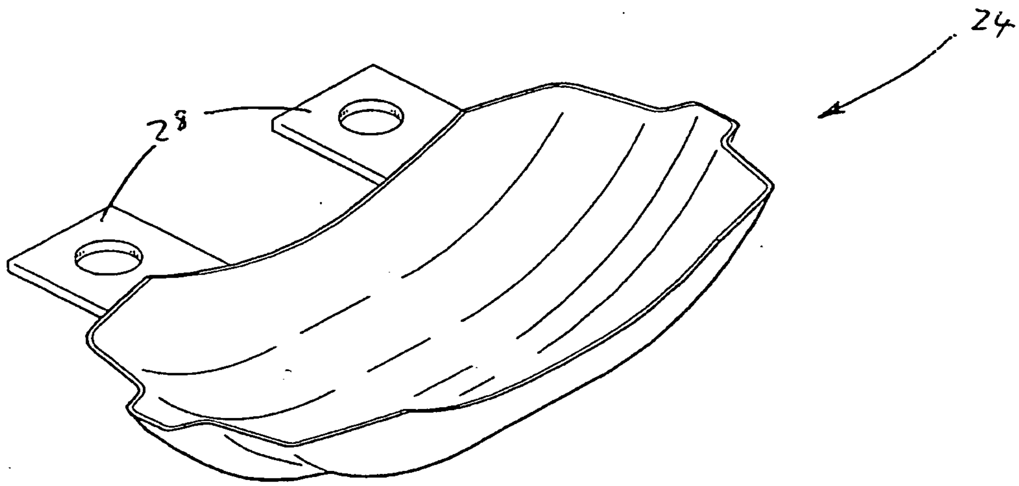

FIG 5

INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F01M11/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 4 519 348 A (HAMILTON EDWARD) 28 May 1985 see column 3, line 38 - column 7, line 5	1,3,12 14,19
A	US 4 270 497 A (VALERIO ROBERT M) 2 June 1981 see the whole document	1
A	US 3 101 129 A (HULTEN) 20 August 1963 see column 2, line 35 - column 4, line 3; figures	1
A	US 4 909 203 A (FUKUO KOICHI) 20 March 1990 see column 2, line 56 - column 10, line 47; figures	1

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

[illegible]tion on patent family members

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